PROJECT FACT SHEET

CONTRACT TITLE: Application of Artificial Intelligence to Reservoir Characterization - An Interdisciplinary Approach

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CONTRACT PERFORMANCE PERIOD:
09/23/1993 to 03/31/1997

PROGRAM: Supporting Research
RESEARCH AREA: Rsvr Characterization

FUNDING ($1000'S)	DOE	CONTRACTOR	TOTAL
PRIOR FISCAL YRS	783	221	1,004
FISCAL YR 1997	0	0	0
FUTURE FUNDS	0	0	0
TOTAL EST'D FUNDS	783	221	1,004

OBJECTIVE: Design and implement an intelligent microcomputer-based system that can be used by small producers and independents to efficiently exploit reservoirs developed in fluvial and fluvial-dominated depositional systems.

METRICS/PERFORMANCE:
Products developed: The benefits relate to the development of a PC-based system in C/C++ for (1) geological identification for fluival dominated deltaic system, (2) for well test analysis, and (3) for integrating dynamic information with geological information. The technological success include (1) identification of sand shapes using neural networks to within 75% agreement of experts, (2) a reservoir description method that includes dynamic production data, (3) correlation of pairwise well-logs within 62%, and (4) an initial well test analysis package that uses geological completion data to determine the well model and parameter estimation.

PROJECT DESCRIPTION:

Background: A neural network is a dense mesh of computing nodes (artificial neurons) that operate collectively and simultaneously to perform summing and non-linear mappings. Simulated annealing is an example of adaptive heuristics for multivariate or combinatorial optimization.

Work to be performed: The main challenge, and unique contribution, of the proposed research will be to integrate diverse reservoir-related information ranging from qualitative and semi-quantitative geological information to statistics. This challenge is increased because the available information is of differing scales and credibility. The resulting expert system has to quickly generate accurate reservoir descriptions honoring all the available "soft" and "hard" data. Such descriptions are of immense value to independent oil producers in evaluating and exploiting mature reservoirs and thereby, enhancing indigenous petroleum production.

PROJECT STATUS:

Current Work: The overall expert system is decomposed into three main component parts: the engineering component, the geological component, and the geostatistical component. These component systems are representative of how the respective experts characterize the reservoir. Each component will interface with a visualization system that present the description consistent with currently available information. Subsystems have been developed for each component and are now being integrated into a single reservoir characterization system. A user interface, which includes a visualization system is under development.

Scheduled Milestones:

Accomplishments: The geostatistical component system incorporates dynamic constraints, such as well test and production data, into a simulated annealing algorithm (a conditional simulation algorithm). This system couples a numerical flow simulator to a simulated annealing algorithm to provide the ability to honor the sample data and create multiple equiprobable reservoir descriptions. In addition, an algorithm has been developed to integrate small-scale geological facies and petrophysical properties through co-simulation method. This method allows simultaneous estimations of rock types, as well as porosity and permeability at a given spatial location. The C++ and FORTRAN subprograms, along with an interface connecting the 3-D information passed between them has been developed.

The petroleum engineering component focuses on a well test interpretation system and has been completed with some remaining refinements. External geological and engineering information, pertaining to geometry, penetration, porosity, and conductivity, is used to limit the choices of an appropriate well model. The model is then identified using relevant data within an expert system encoded in C++. Time and pressure information used to determine the shape of the type curve and resulting model choices. The choices from the two systems are compared for more accurate model determination. Once a model is identified, first estimates of various parameters are obtained. A graphing facility is being incorporated into the program. Additional geological information is being collected to integrate the well-test system into the overall reservoir characterization system.

The geological system component has three subsystems: the marker bed detection system, the log facies description system and the correlation system. The majority of the recent research has been placed on this effort, since it is proving to be very difficult. An algorithm has been developed to determine the main marker bed with a 69% accuracy. The potential marker beds of those wells in which the main marker bed cannot be identified are presented to the user for final determination. Then, a neural network is used for facies identification within 65% of expert agreement. The correlation system has been devised using 189 rules that rank possible correlations of the facies determined by the neural network according to the facies type, distance from the marker bed, relative well position, and thickness of the facies. A matrix is built using the ranks, An expert system has been developed using geological information that accurately correlates the well zones within 62% of geological experts. A visualization system is being developed to allow the user to change the correlation interactively. In addition, a system is under development to produce 3-D correlations to provide information to the geostatistical system.